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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003905174 for a patent by U.S. FILTER WASTEWATER GROUP, INC. as filed on 22 September 2003.

WITNESS my hand this
First day of October 2004

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AUSTRALIA

PATENTS ACT 1990

PROVISIONAL SPECIFICATION

FOR THE INVENTION ENTITLED:-

"Backwash and Cleaning Method"

The invention is described in the following statement:-

TITLE: Backwash and Cleaning Method

FIELD OF THE INVENTION

The present invention relates to concentration of solids in a suspension using hollow fibre membranes and, in particular, to an improved method of backwashing and chemically cleaning the hollow fibre membranes.

BACKGROUND ART

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

Known backwash systems include those described in our earlier International Application No. WO93/02779 the subject matter of which is incorporated herein by cross-reference.

A pressurized liquid backwash of hollow fibre membranes has been found to be uneven along the length of the fibre membranes due to the frictional losses along the lumen. In membranes with the fibres closed at one end, the pressure of liquid is highest at the point of application of the pressurized flow to the fibres lumens and tapering off along the length of the membrane. This results in uneven backwashing and poor recovery of TMP at portions of the fibres remote from the backwash application point. In fibres open at both ends, the backwash flow is a minimum towards the centre of the fibre.

During chemical cleaning of membranes, cleaning solutions are often backflushed from the lumen side of the membrane to distribute the cleaning solution within the membrane fibre bundle. Applying the cleaning solution under pressure assists the removal of foulants from the surface. However, the

limitations of pressure drop down the lumen during this step mean that achieving the same applied transmembrane pressure (TMP) to all areas of the membrane cannot be readily achieved, especially for small diameter fibres where the pressure loss is greatest. This impacts on the efficiency of cleaning.

DISCLOSURE OF THE INVENTION

It is an object of the invention to overcome or at least ameliorate one or more of the disadvantages of the prior art or at least provide a useful alternative.

According to a first aspect, the present invention provides a method of concentrating the solids of a liquid suspension comprising:

(i) providing a pressure differential across the walls of permeable, hollow membranes immersed in the liquid suspension, said liquid suspension being applied to the outer surface of the porous hollow membranes to induce and sustain filtration through the membrane walls wherein:

(a) some of the liquid suspension passes through the walls of the membranes to be drawn off as clarified liquid or permeate from the hollow membrane lumens, and

(b) at least some of the solids are retained on or in the hollow membranes or otherwise as suspended solids within the liquid surrounding the membranes,

(ii) periodically backwashing the membrane pores using the permeate by applying a gas at a pressure below the bubble point to the membrane lumens to progressively displace at least some of the liquid permeate within the lumens through the membrane pores resulting in removal the solids retained on or in the hollow membranes into the bulk liquid surrounding the membranes.

This process ensures that the differential pressure applied during backwash is close to the gas pressure at the liquid interface as it travels down the lumen thereby ensuring that the maximum differential pressure is applied across the membrane wall at all points, although not simultaneously.

According to a second aspect, the present invention provides a method of concentrating the solids of a liquid suspension comprising:

(i) providing a pressure differential across the walls of permeable, hollow membranes immersed in the liquid suspension, said liquid suspension being applied to the outer surface of the porous hollow membranes to induce and sustain filtration through the membrane walls wherein:

(a) some of the liquid suspension passes through the walls of the membranes to be drawn off as clarified liquid or filtrate from the hollow membrane lumens, and

(b) at least some of the solids are retained on or in the hollow membranes or otherwise as suspended solids within the liquid surrounding the membranes,

(ii) dislodging the retained solids from the membranes by applying a dislodging medium through the lumens of said membranes while concurrently draining liquid from said lumens, wherein the application of the dislodging medium initially displaces liquid within the hollow membrane lumens through the hollow membrane with gas, to effect firstly a discharge of liquid in the lumens through the membrane walls, and secondly a transmembrane cleaning of the membranes by applying the gas at sufficient pressure onto the liquid to overcome the bubble point of the membrane, and ensure that the gas will displace liquid and follow it through the larger pores of the membranes to

dislodge any solids retained therein; and for the emerging gas to scour the external walls of the membranes and displace the removed solids into the bulk liquid surrounding the membranes.

Preferably, said method is carried out as a continuous process utilising a repetitive cycle of solid accumulation and solid discharge.

According to a third aspect the present invention provides a concentrator for recovering fine solids from a liquid feed suspension comprising:

(i) a vessel for containing said feed suspension;

(ii) a plurality of permeable, hollow membranes within the vessel;

(iii) means for providing a pressure differential across walls of said membranes;

(iv) means for withdrawing clarified liquid from the membrane; and

(v) means for applying gas at a pressure below the bubble point to the liquid permeate in the membrane lumens to effect a discharge of at least some of the liquid permeate in the lumens through the membrane walls to dislodge any solids retained therein and displace the removed solids into the bulk liquid surrounding the membranes.

According to a fourth aspect the present invention provides a concentrator for recovering fine solids from a liquid feed suspension comprising:

(i) a vessel or tank for containing said feed suspension;

(ii) a plurality of permeable, hollow membranes within the vessel or tank;

(iii) means for providing a pressure differential across walls of said membranes;

(iv) means for withdrawing clarified liquid from the membrane; and

(v) means for applying gas pressure to the liquid in the membrane lumens and walls while the vessel or tank is exposed to atmospheric pressure and while concurrently draining liquid from said lumens, to effect firstly a discharge of liquid in the lumens through the membrane walls, and secondly a transmembrane cleaning of the membranes by applying the gas at sufficient pressure onto the liquid to overcome the bubble point of the membrane, and ensure that the gas will displace liquid and follow it through the larger pores of the membranes to dislodge any solids retained therein; and for the emerging gas to scour the external walls of the membranes and displace the removed solids into the bulk liquid in the vessel or tank.

Preferably, the backwash includes use of clean-in-place (CIP) chemical solutions as well as or instead of the filtrate. This may be employed in a number of different backwash methods.

One such backwash method includes filtering the chemical cleaning solution from the shell side, that is, from the outer surface or vessel side of the membrane into the membrane lumens. The normal backwash is then performed and the chemical solution forced back through the membrane pores in an even fashion by applying a gas as described above.

Another alternate form of chemical backwash includes backwashing initially with filtrate, that is, pushing the filtrate in a reverse direction through the membrane pores while injecting chemical cleaning solution into the filtrate. The filtrate/chemical solution mixture is then backwashed through the membrane by applying a gas as described above.

Yet another alternate form of chemical backwash includes applying chemical cleaning solution under pressure to the shell side of the membranes to

force chemical cleaning solution through the membrane pores and fill the membrane lumens with the chemical cleaning solution. This is followed by the normal gas backwash described above.

Each of the above chemical cleaning methods has been found to provide a more efficient chemical backwash. The methods allow for a minimal use of chemical cleaning solution while also enabling an enhanced washing process by providing a more efficient distribution of the chemical cleaning solution within the system. Desirably, these backwashes or cleans are performed on an intermittent basis.

Using the methods described the reverse flow cleaning step can be accomplished in such a way as to allow the transmembrane pressure (TMP) to be controlled by the gas pressure and to apply this TMP evenly along the fibre, even at the extremities from the lumen inlet. This ensures all areas of the fibre are contacted with cleaning chemical and that they are back-flushed with the same applied TMP. It also allows the chemical in the lumens to be fully drained by the end of the reverse flow step, which aids in recovery of cleaning chemical, reduces flushing requirements, and reduces cleaning downtime.

In one preferred form, the gas may be pulsed in its application to the membrane lumens. In one alternate form of the chemical solution backwash described above, the backwash is performed with the vessel empty.

The process can be applied to membranes submerged in an open vessel as well as pressurized membrane filtration systems.

The invention may be embodied in a similar apparatus to that described in the aforementioned International Application No. WO93/02779 appropriately modified to operate in accordance with the inventive method.

It will be appreciated that further embodiments and exemplifications of the invention are possible without departing from the spirit or scope of the invention described.

DATED this 22nd day of September, 2003

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